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12/2/03

Figure 2 Typical optical verniers



Figure 1 Typical overlay patterns or completed alignment attributes

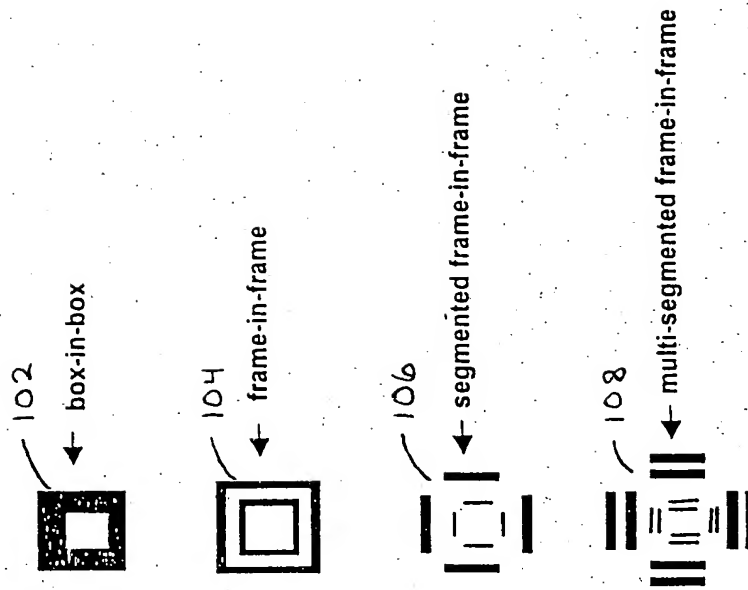


Figure 3 Reticle

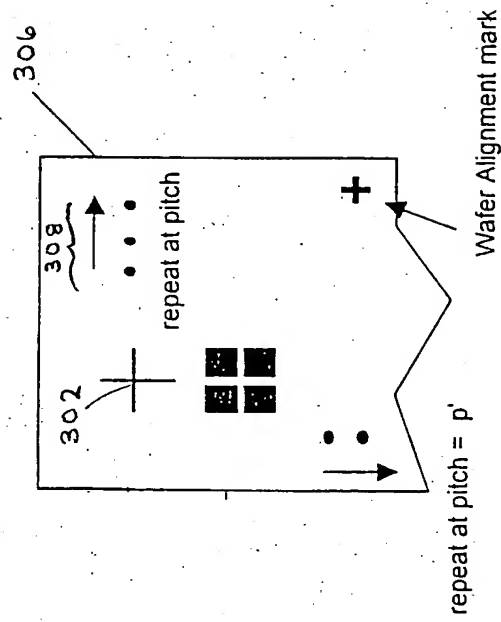


Figure 4 Overlapped male and female target pairs

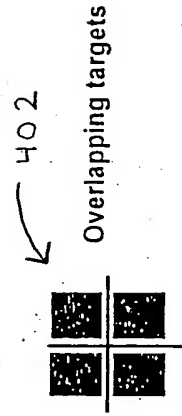


Figure 5 Features of figure 5 in developed positive photoresist

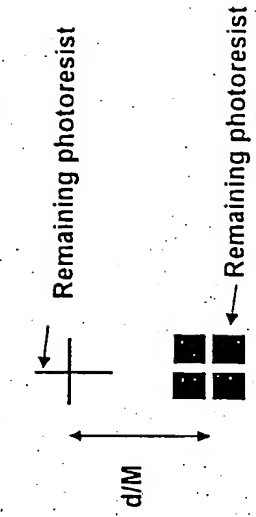


Figure 6 Detail of reticle for figure 3

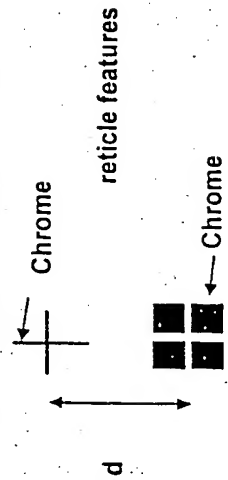


Figure 6 An embodiment process flow for creating reference wafer

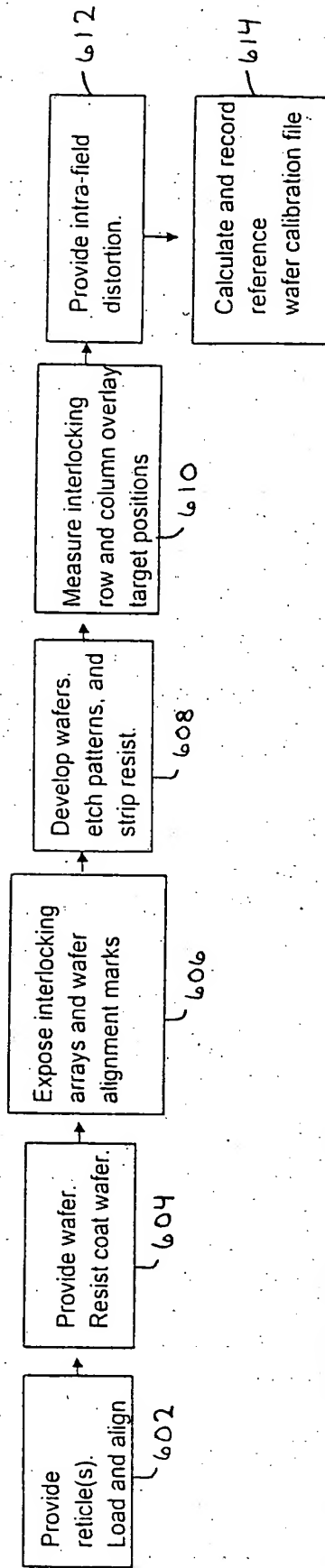


Figure 7 An embodiment process flow for creating reference wafer.

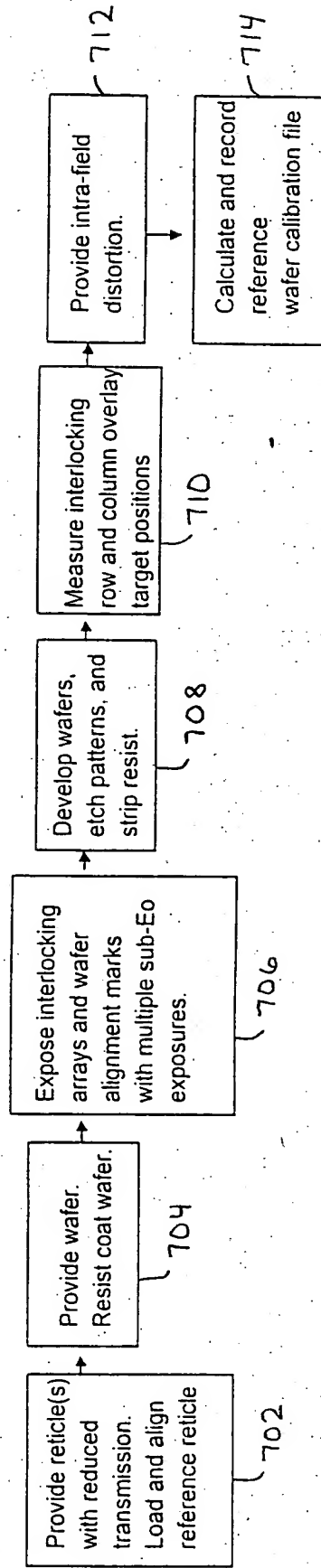


Figure 8 Example application of reference wafer

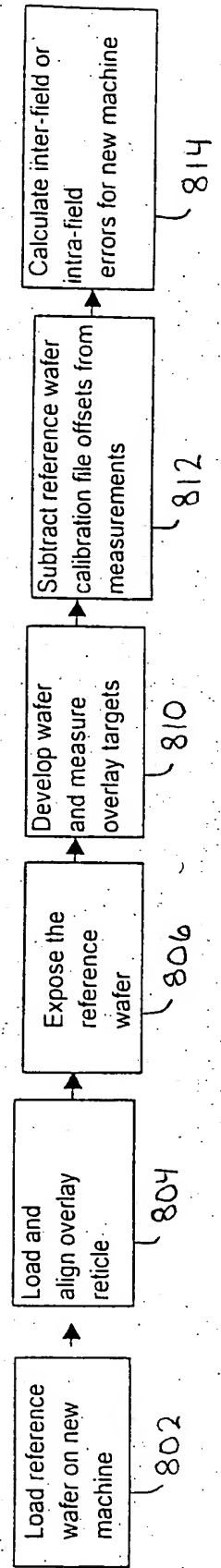


Figure 9 Common causes of overlay or placement error (Inter-field and Intra-field)

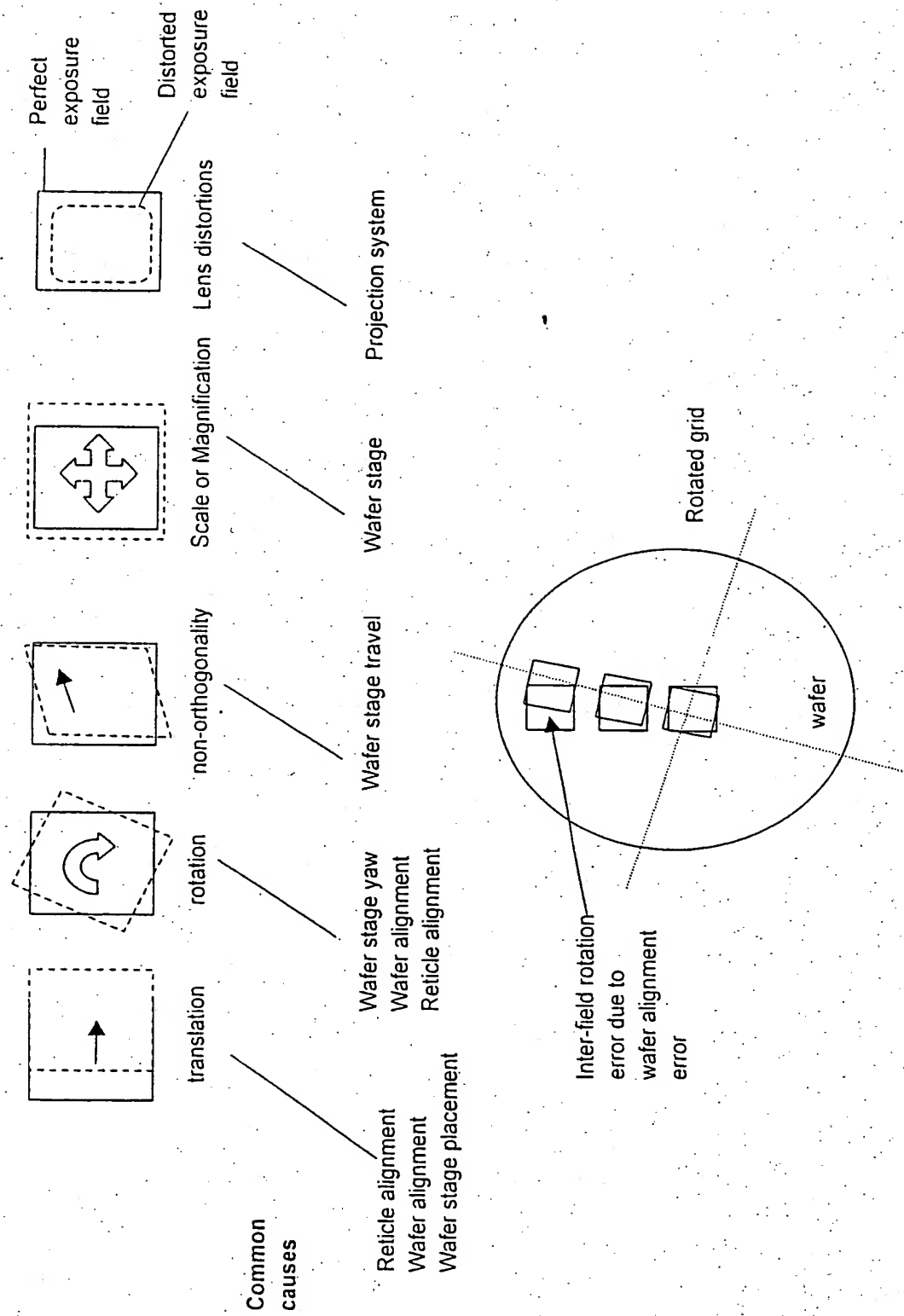


Figure 10 Photolithographic stepper or scanner system

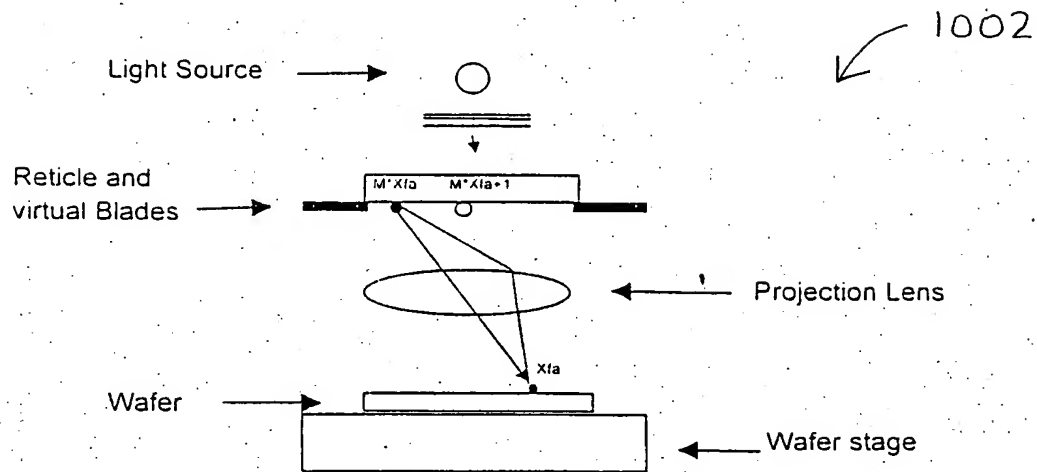


Figure 11A Inter-field and intra-field overlay error

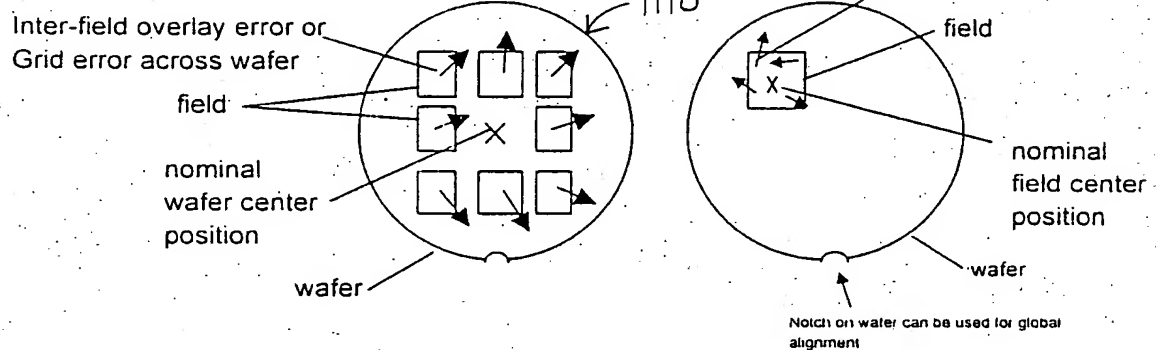


Figure 11B Interfield Yaw error

zero yaw = solid line fields
non-zero yaw = dashed fields

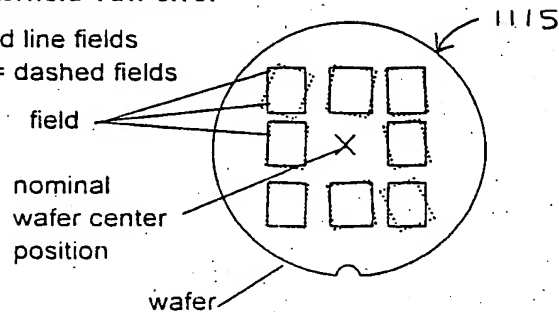


Figure 12 Detail of interlocking fields in X and Y directions on the reference wafer, 3 fields shown.

Solid lines = field (i, j)

Dashed lines = field (i, j+1)

Dotted lines = field (i+1, j)

Filled squares = field (i+1, j+1)

S_x = X field pitch = $N_x \cdot P/M$

S_y = Y field pitch = $N_y \cdot P/M$

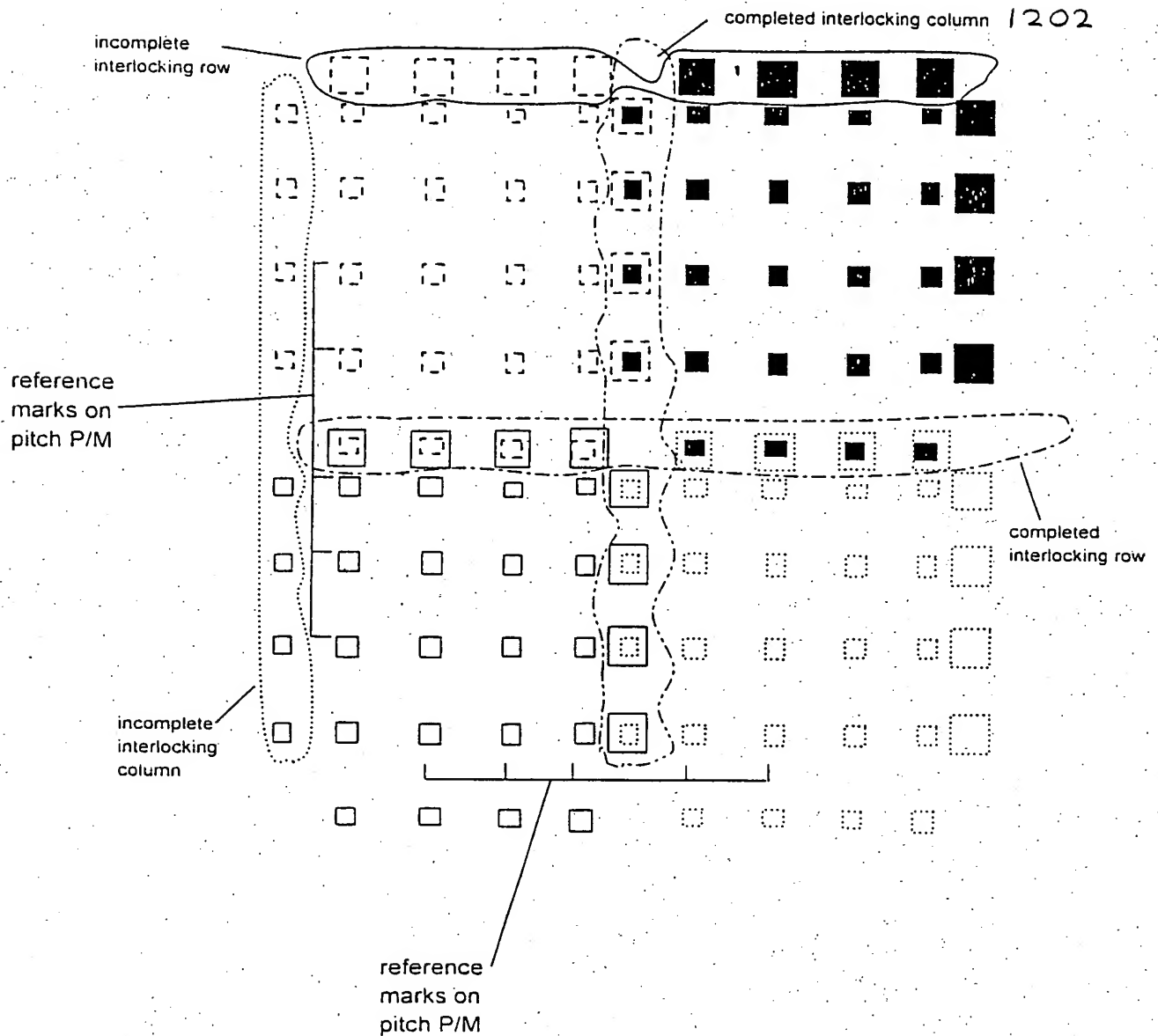


Figure 13A Reference reticle of the present invention. This reticle contains a complete $N_x \times N_y$ interlocking array and no wafer alignment marks.

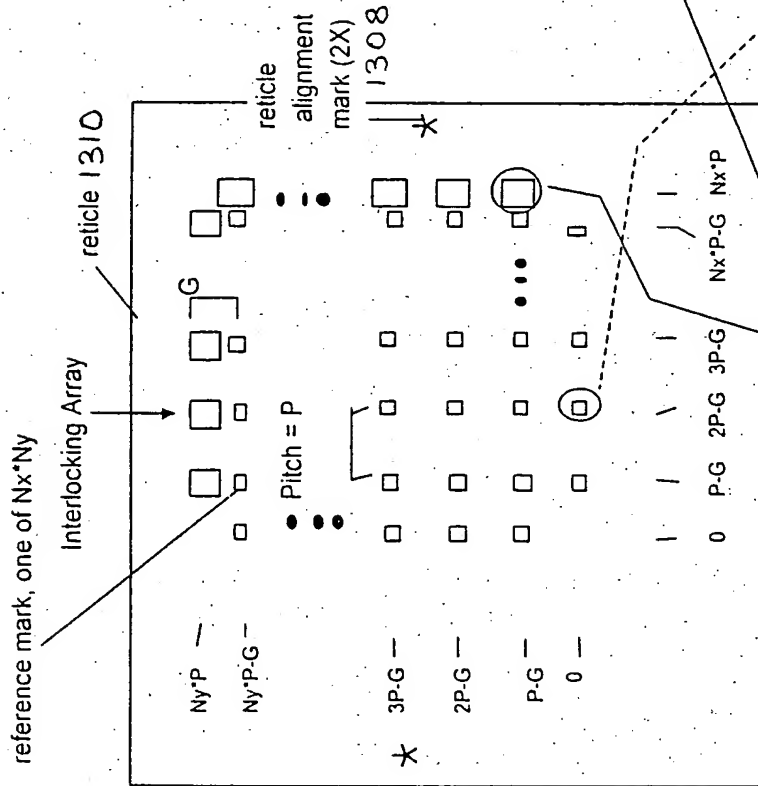


Figure 13B Reference reticle containing wafer alignment marks, portion of interlocking array and complete interlocking rows and columns. One reticle of a set.

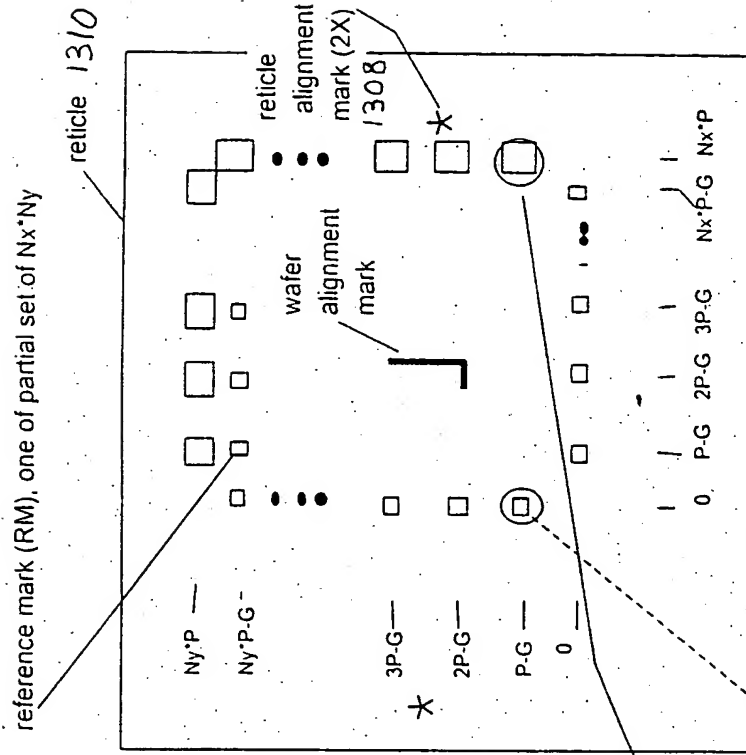


Figure 13C Exemplary inner and outer box sizes. Design of figure 13A and 13B, μm = microns.

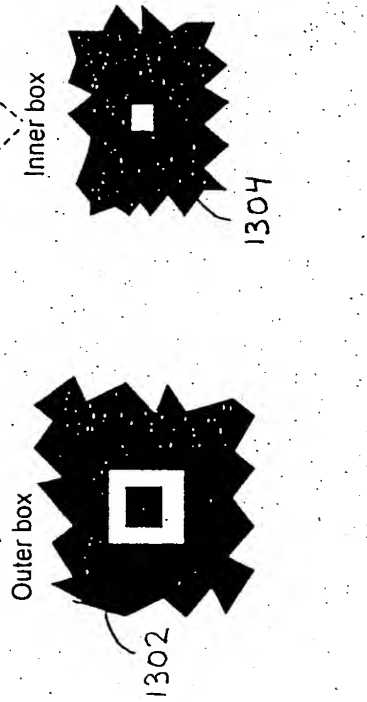


Figure 14 Side view of reference reticle

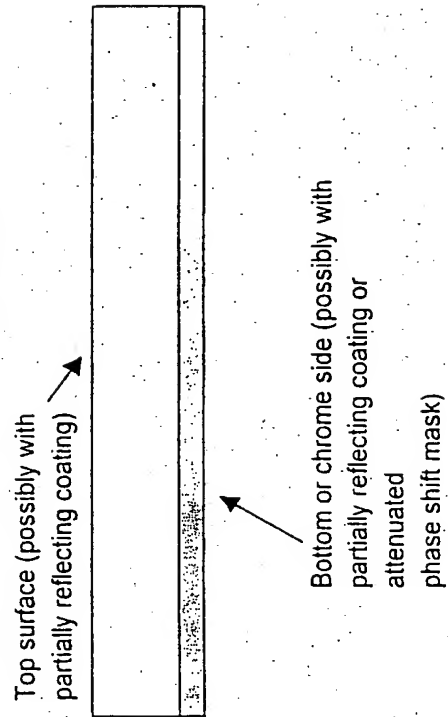
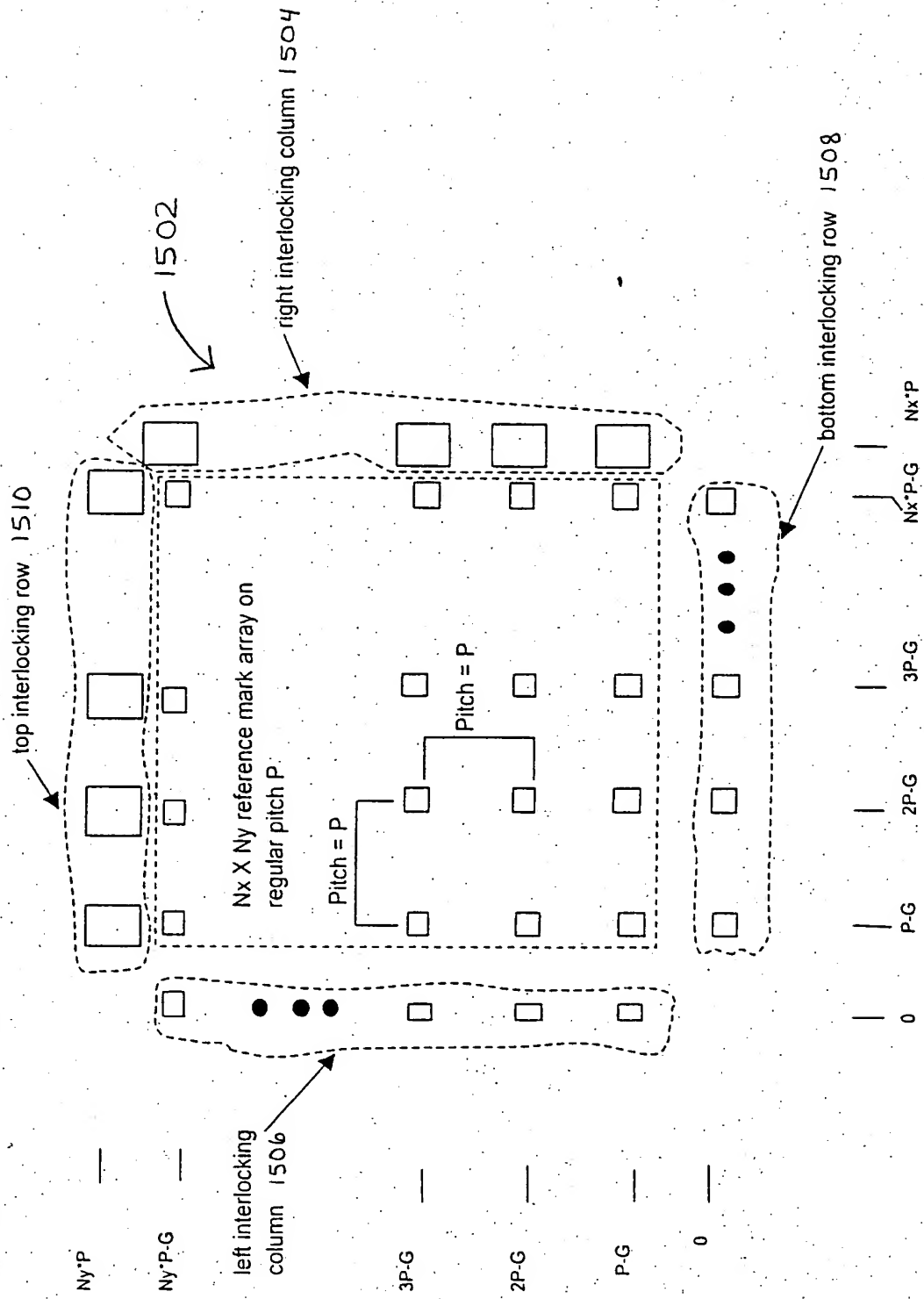


Figure 15 Further explanation of the components of the interlocking array of the reference reticle of figure 13A



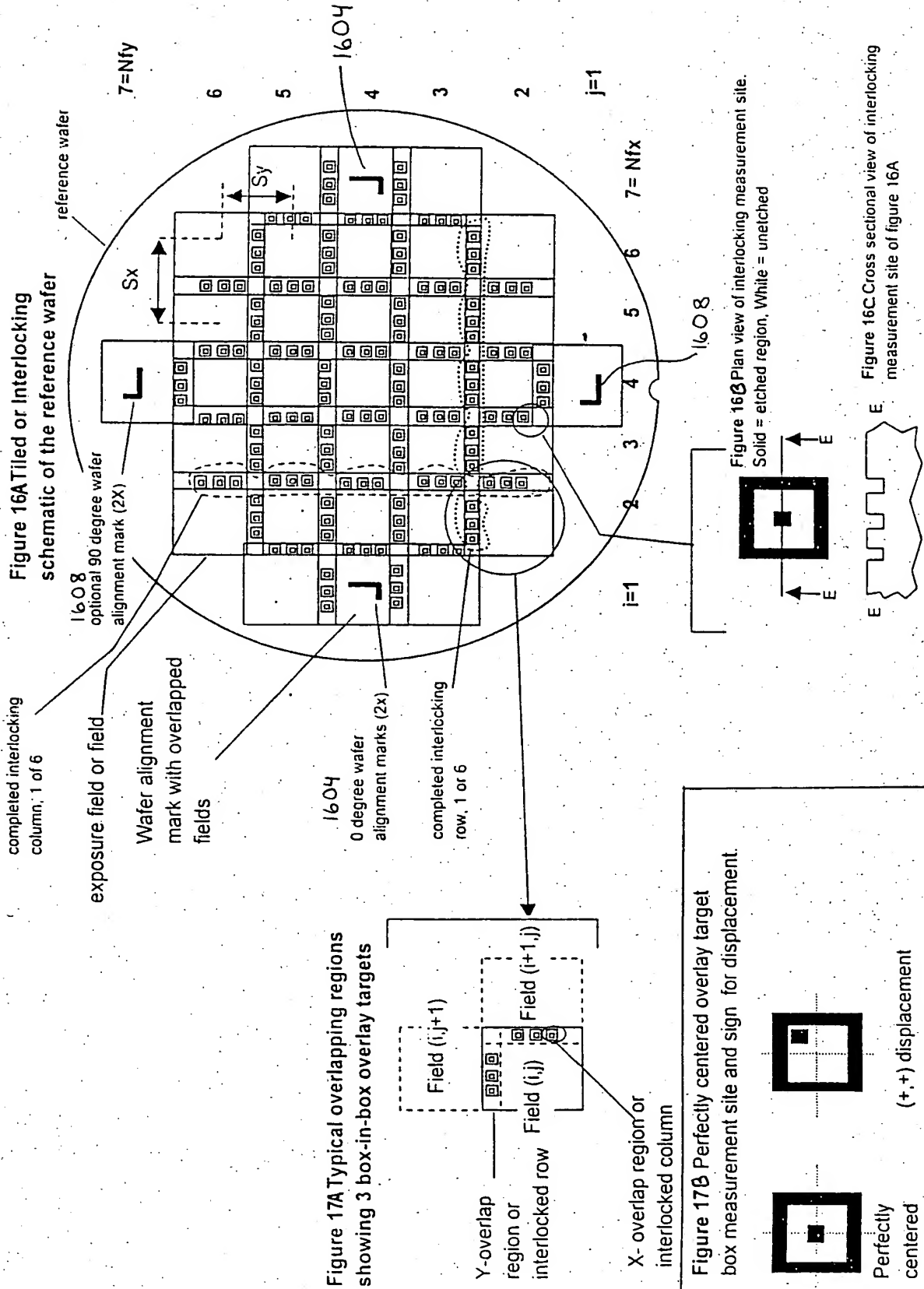


Figure 18 Overlay error
vector plot

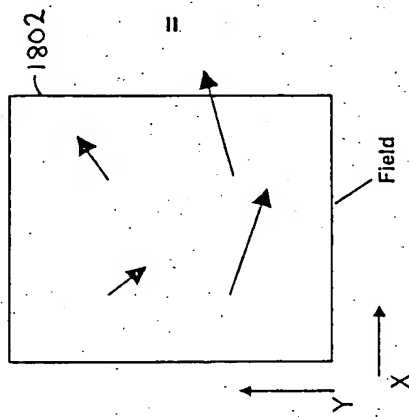


Figure 19 Translation overlay
vector plot

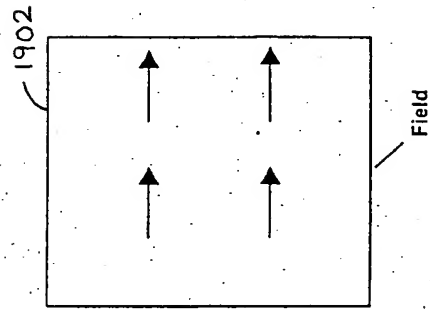


Figure 20 Rotation
overlay vector plot

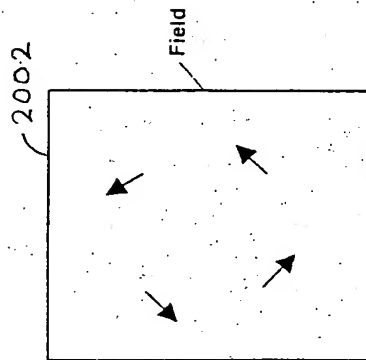
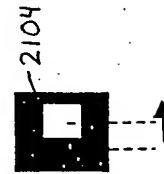
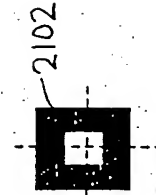


Figure 21 Overlay measurement notation



The vector represents the alignment offset distance
between the box-in-box structure



Perfectly centered box in box structure

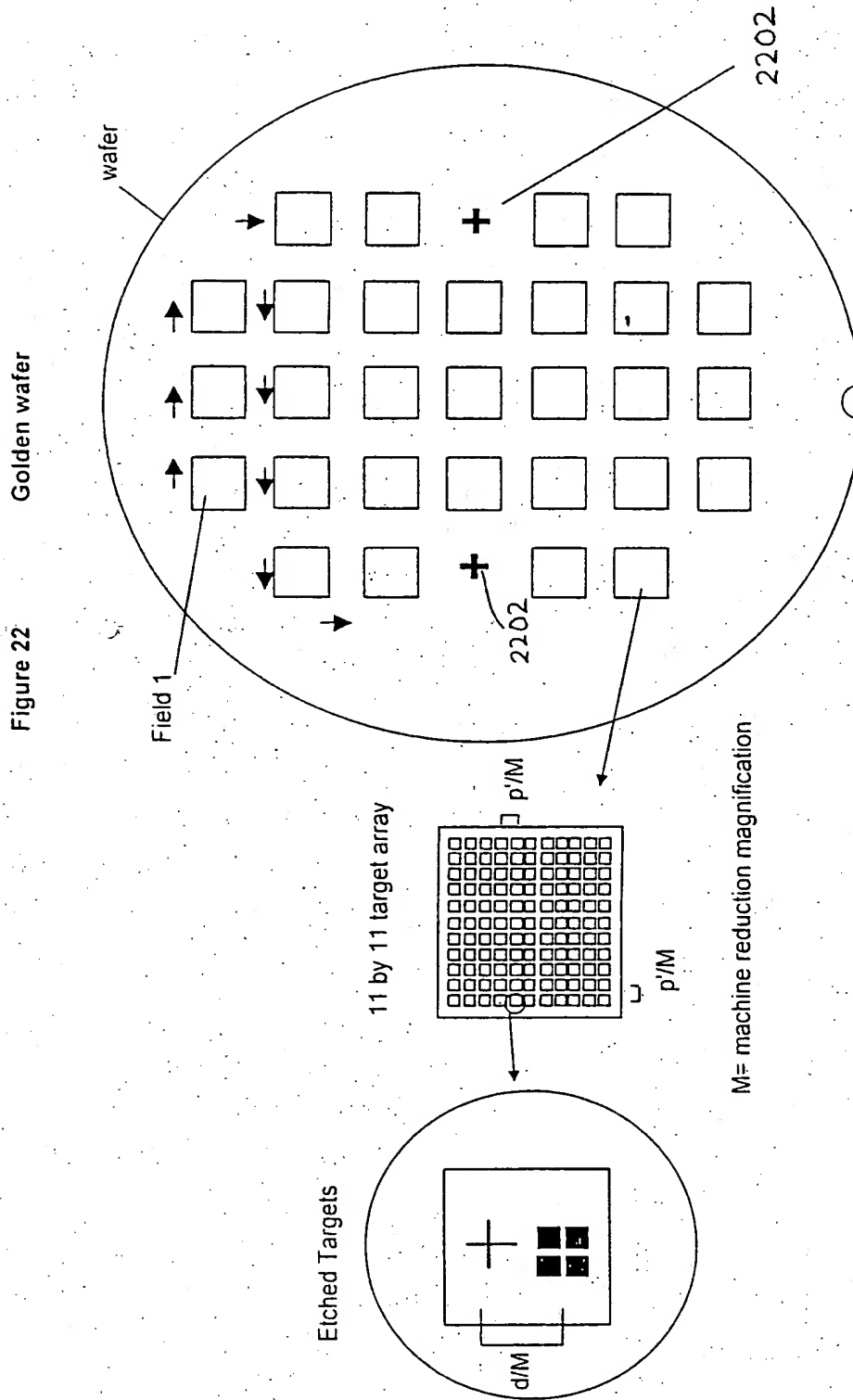


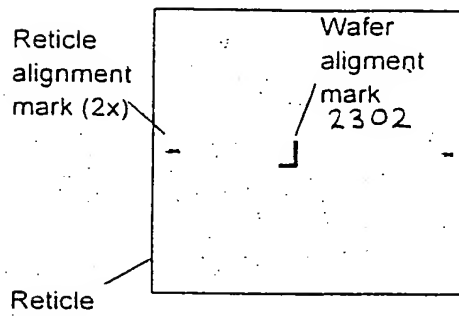
Figure 23 Wafer alignment
mark reticle

Figure 24 Inner box reticle

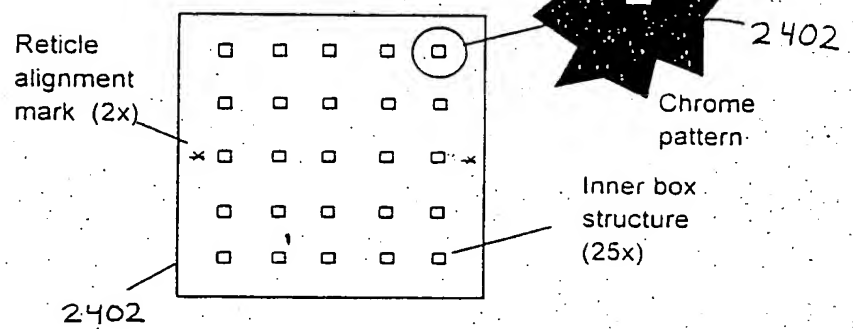
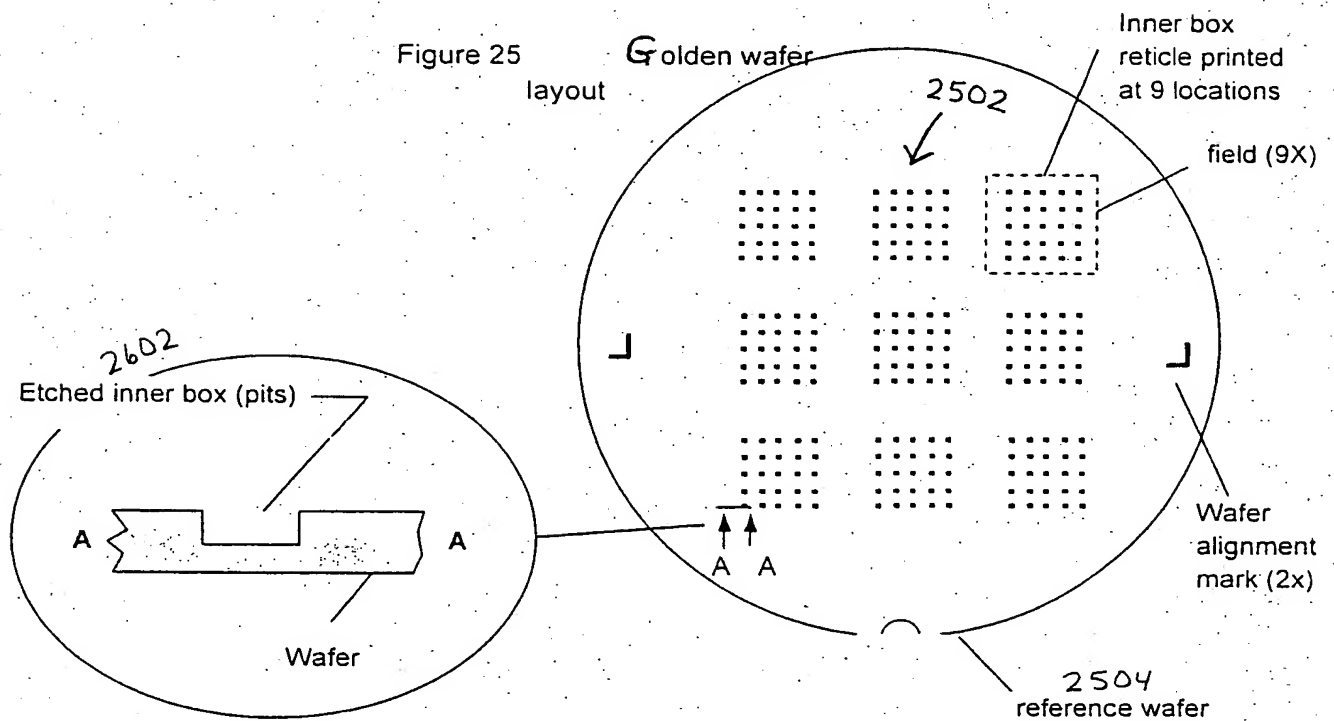
Figure 25
layout

Figure 26 Cross section of inner box

Figure 27 Outer box reticle schematic

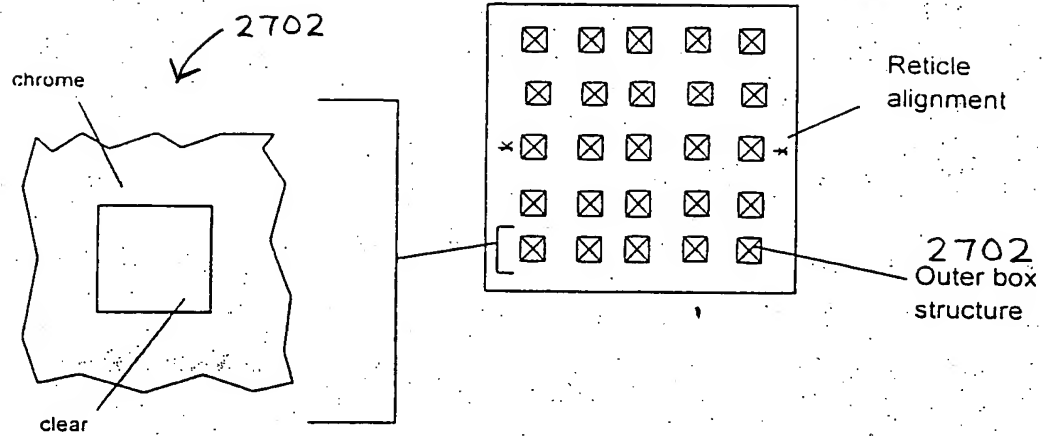


Figure 28 Outer box reticle detail

Figure 29 Golden wafer ready for overlay measurement

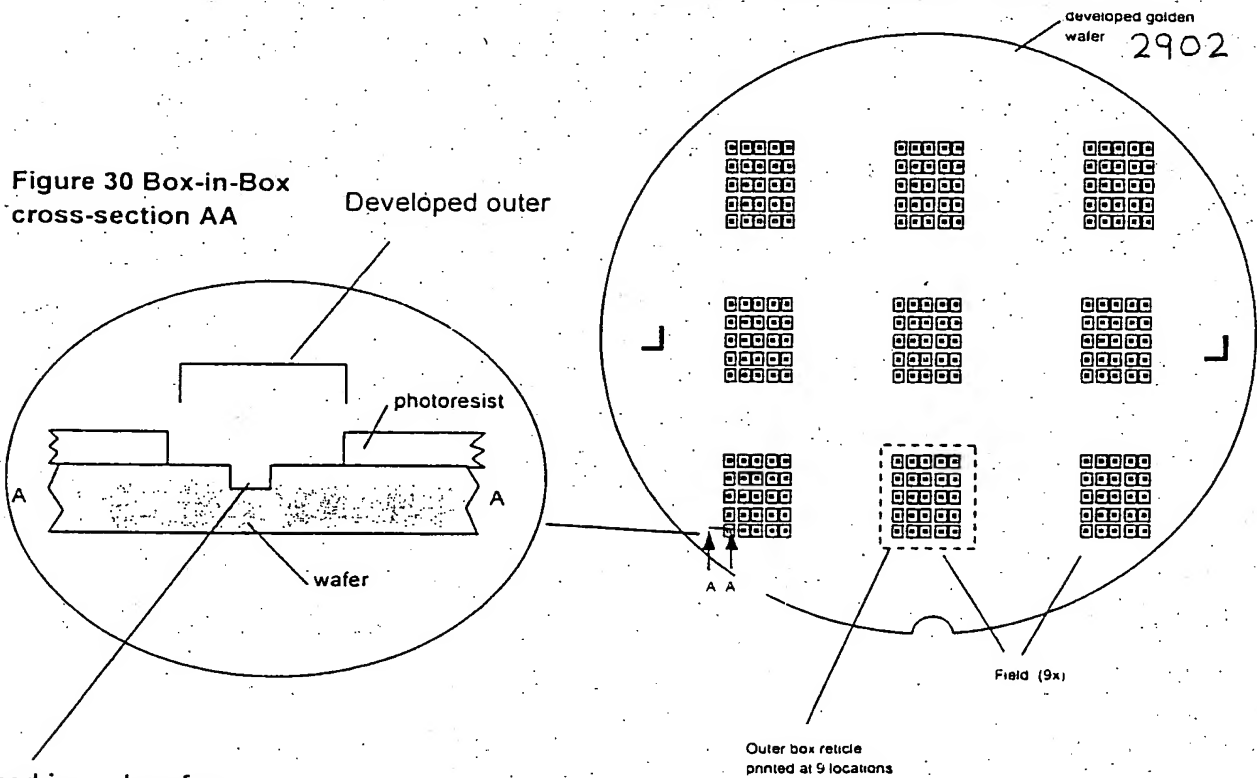
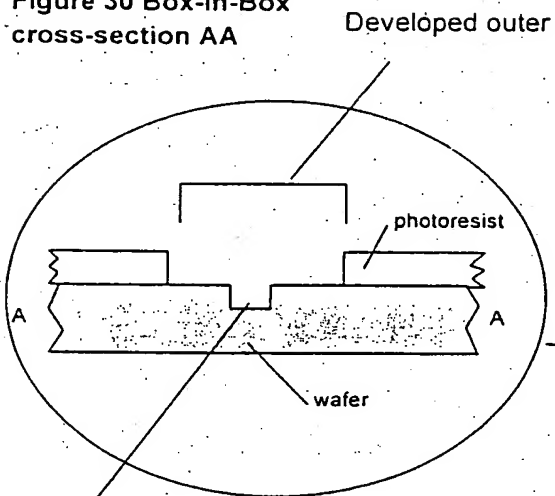


Figure 30 Box-in-Box cross-section AA



Etched inner box from
reference stepper or scanner

Figure 31 Inter-field and Intra-field indices

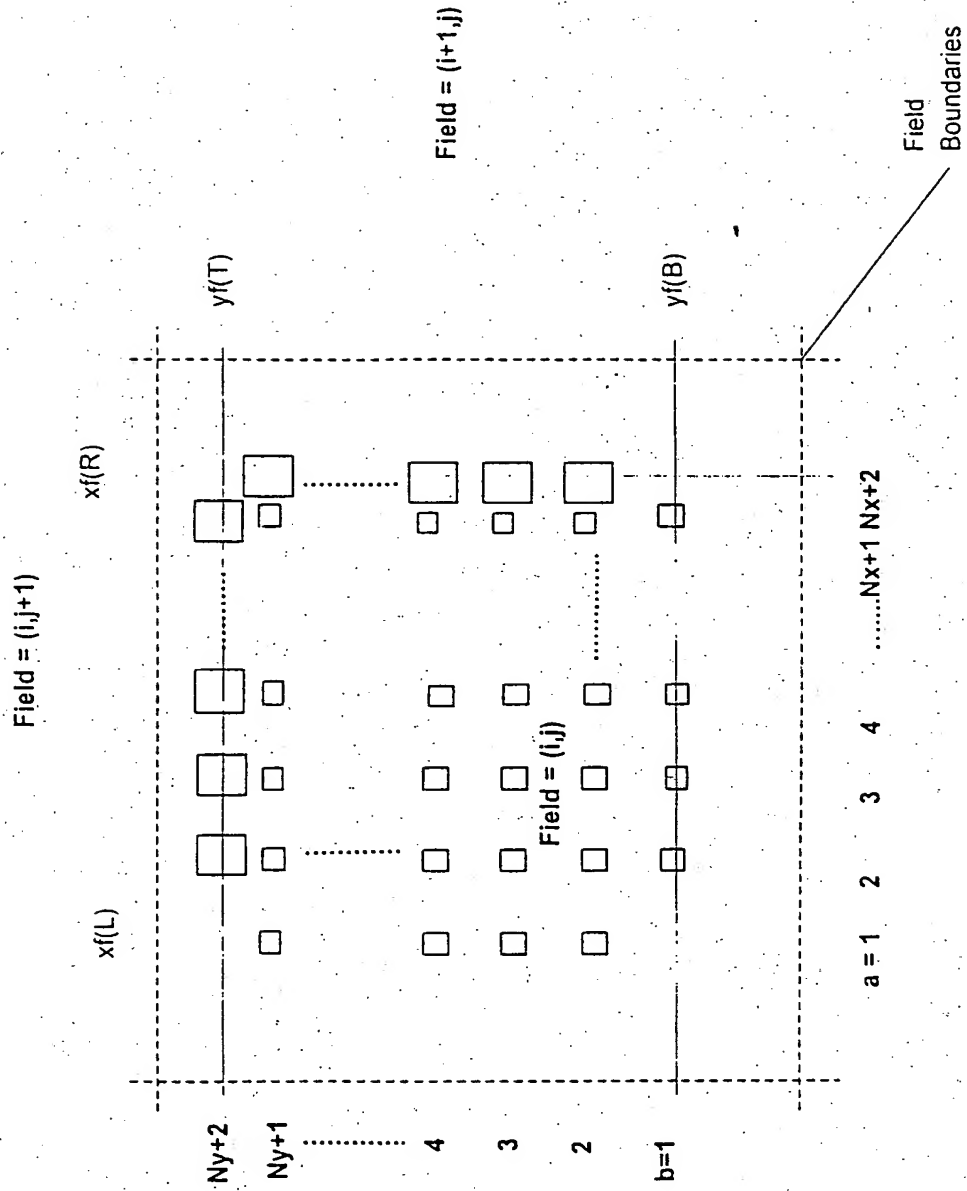


Figure 32 Partially exposed field and
interlocking box-in-box structures along
Field (i,j+1)'s' left edge

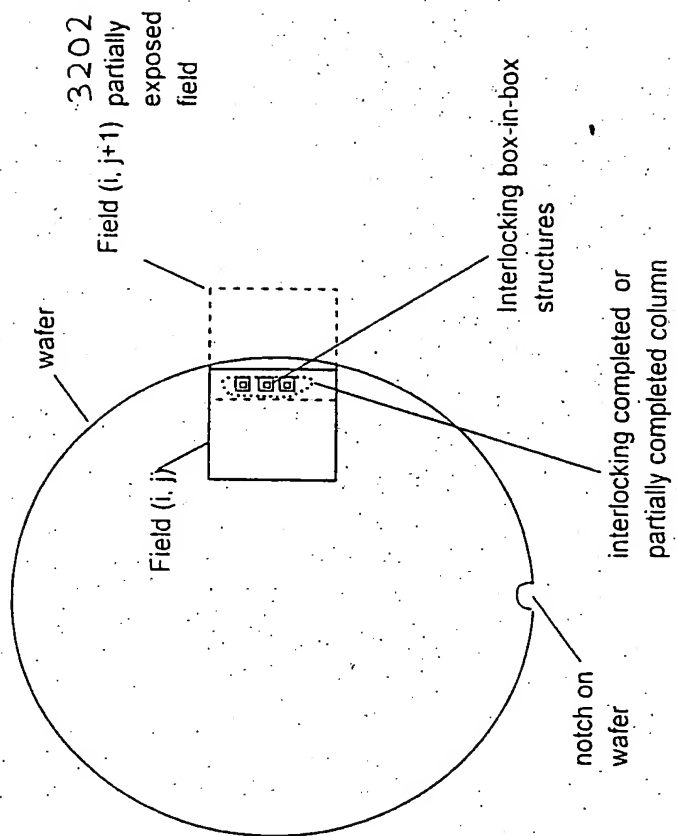


Figure 33 Operational portions of completed reference wafer

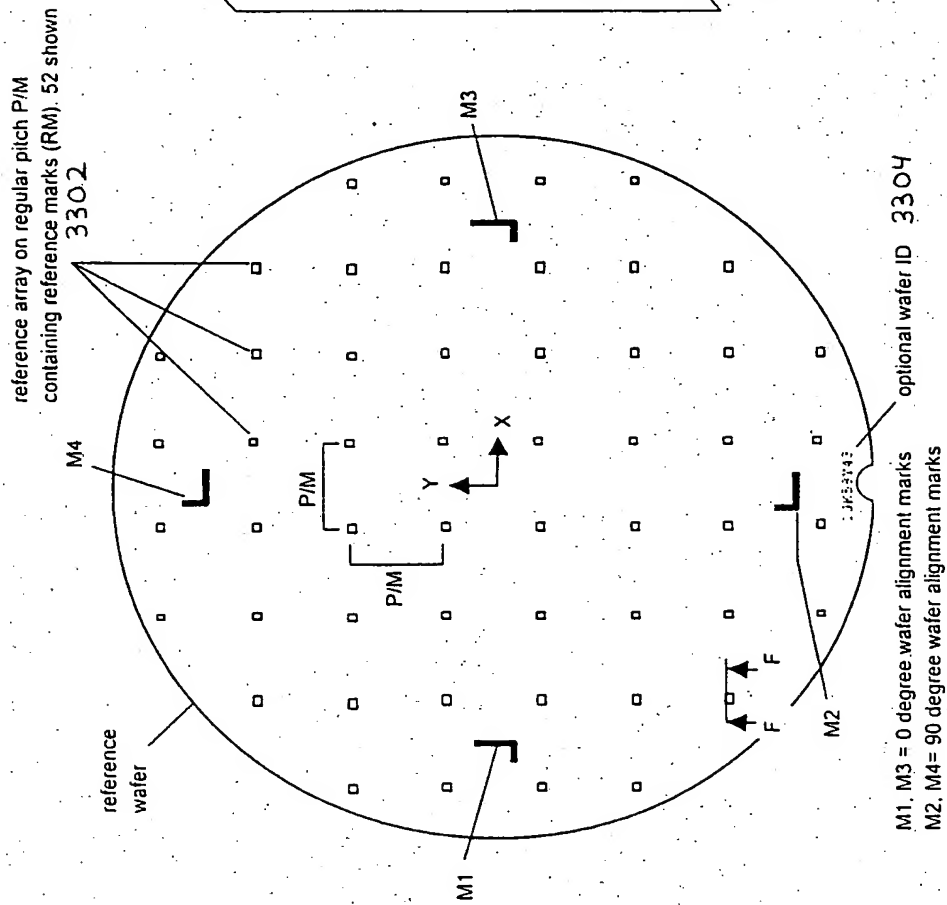


Figure 34 Exemplary calibration file for reference wafer of figure 33 (units = mm).

Feature	XG	YG	dx	dy
M1	-95.000000	0.000000	0.000050	-0.000037
M2	0.000000	-95.000000	-0.000037	0.000050
M3	95.000000	0.000000	0.000050	-0.000037
M4	0.000000	95.000000	-0.000037	0.000050
RM	10.000000	10.000000	0.000050	0.000037
RM	10.000000	20.000000	0.000050	-0.000037
RM	-60.000000	-80.000000	0.000039	0.000049

52 entries
for wafer of
figure 33

Figures 35A:35F show cross section FF of Figure 33 and details a variety of vertical structures possible for the reference mark (RM).

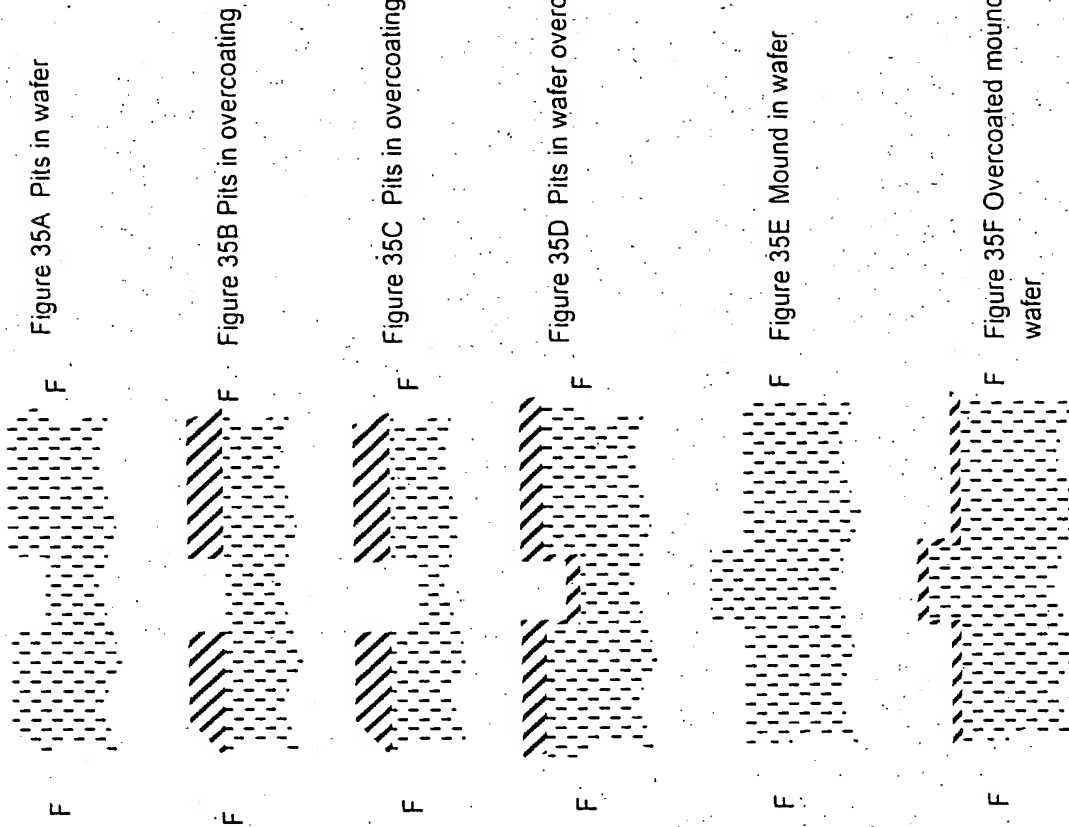


Figure 36 Tiled or interlocking schematic for reference wafer containing only wafer alignment marks and interlocking rows and columns.

